

REMARKS

The Applicants have studied the Office Action dated November 30, 2004 and have made amendments to the claims to distinctly claim and particularly point out the subject matter which the Applicants regard as the invention. No new matter has been added. It is submitted that the application, as amended, is in condition for allowance. Claims 13 and 21 have been canceled without prejudice. Claims 1, 5, 9, 12, 17 and 20 have been amended. New claims 25 and 26 have been added. By virtue of this amendment, claims 1-12, 14-20 and 22-26 are pending. Reconsideration and allowance of the pending claims in view of the above amendments and the following remarks is respectfully requested.

New Claims

The Applicants have added new dependent claim 25, which depends from amended independent claim 9. New dependent claim 25 defines:

The method of claim 9, wherein the first plurality of images further comprises a third image, the method further comprising:

detecting, on a third processor, a third set of distinct image features in the third image;

determining, at the third processor, a second correspondence of distinct image features between the third set of distinct image features and at least the second set of distinct image features; and

communicating, as part of the plurality of correspondences of distinct image features, the second correspondence to the second processor, and

wherein the second plurality of images comprises the first image, the at least a second image, and the third image.

Support for new dependent claim 25 is found in the specification at, for example, page 13, lines 22-24; page 15, lines 11-17; page 16, lines 16-23 and page 18, lines 1-14. No new matter was added by this amendment.

The Applicants have added new dependent claim 26, which depends from amended independent claim 9. New dependent claim 26 defines:

The method of claim 9, wherein the at least a second image comprises a second image and a third image, the method further comprising:

detecting, on a third processor, a third set of distinct image features in the third image, and

wherein the determining a second correspondence comprises comparing three images using a trifocal tensor method, and

wherein the communicating further comprises communicating the third set of distinct image features and, as part of the plurality of correspondences of distinct image features, the second correspondence to the second processor.

Support for new claim 26 is found in the specification at, for example, page 14, line 20 to page 15, line 3. No new matter was added by this amendment.

The Applicants respectfully assert that the cited prior art references do not teach or suggest the limitations contained in new claims 25 and 26. The Applicants therefore respectfully submit that new claims 25 and 26 should be allowed.

Claim Objections

The Examiner objected to claim 1 based upon an assertion that the specification only describes a "single initial correlator" and does not discuss "a plurality of initial image correlators..." as is recited by claim 1. The Examiner correctly points out that the "2-view image comparator" described in the specification corresponds to the "initial image correlator" in the exemplary embodiment of that particular embodiment. The Applicants respectfully point out, however, that the 2-view image comparator described at page 16, lines 19-20 of the specification is part of the exemplary digital signal processor 115 illustrated in FIG. 2. See, specification, page 13, lines 17-18. As described in the specification, the exemplary digital signal processor 115 "is also representative of the other digital processors 117, 119 in the present example." Specification, page 13, lines 19-20. Further, the specification states the "digital processors 115, 117, 119 each share a common architecture and a similar processing is performed within each digital processor that is distributed among the cameras used by the preferred embodiments." Specification, page 13, lines 21-24. The Applicants respectfully

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point out that independent claim 1 is directed to "an image processing system" and that the specification describes an "exemplary image processing system 100" in FIG. 1. The exemplary image processing system 100" described in the specification does, in fact, include three digital processors 115, 117, 119. As discussed above, these three digital processors each includes a "2-view image comparator," or initial image correlator. Therefore, the Applicants believe that the specification sufficiently supports this claim limitation and request that the Examiner withdraw the objection to claim 1.

As discussed above, the Applicants respectfully assert that the specification adequately supports the limitations of independent claim 1. Therefore, the Applicants also request that the Examiner withdraw the objection to claims 2-8, which directly or indirectly depend from claim 1.

The Examiner objected to claim 14, and similarly to claims 6 and 22, based upon an assertion that the specification says nothing about the feature included in these claims of "determining maximum average strength of correspondence based at least in part on a total number of matching neighbor distinct image features." The Applicants respectfully point out that the specification of the subject patent application explicitly incorporates by reference U. S. Patent Application No 09/825,266 by Chen (hereinafter '266 application). Specification page 1, lines 11-13 and page 10, lines 23-26.

The Applicants respectfully point out that the '266 application does describe this limitation. For example, the determination of the quantity of this limitation is discussed in the '266 application at page 13, lines 4-17. The use of this quantity is discussed in the '266 application at page 12, line 17 through page 13, line 2. The Applicants respectfully assert that sufficient support for this claim limitation is found in the '266 application, which was properly incorporated by reference into the present application. Therefore, the Applicants request that the Examiner withdraw the objection to claims 14, 6 and 22.

The Examiner further objected to claim 15, and similarly to claims 7 and 23, based upon an assertion that the specification says nothing about the feature included in these claims of "determining maximum average strength of correspondence based at least in part on a total number of matching neighbor distinct image features." The Applicants respectfully point out that the '266 application does describe this limitation. For example, the computation and use of reprojection errors is discussed in the '266 application at page 15, line 21 through page 16, line 28 and on page 18, lines 4-16. The Applicants respectfully assert that sufficient support for this claim limitation is found in the '266 application, which was properly included in the present application by reference. An application for a patent may incorporate "essential material" by reference to a U.S. patent application. MPEP 608.01(p)(I) (A). Therefore, the Applicants request that the Examiner withdraw the objection to claims 15, 7 and 23.

The Examiner also objected to claim 16, and similarly to claims 8 and 24, based upon an assertion that the specification says nothing about the feature included in these claims of "a second potential match set is based at least in part on a least median of squares computation of the reprojection of the reprojection errors related to matched distinctive image points in the at least a second potential match set." The Applicants respectfully point out that the '266 application does describe this limitation. For example, the '266 application includes a discussion of this limitation at page 18, lines 4-16. The Applicants respectfully assert that sufficient support for this claim limitation is found in the '266 application, which was properly included in the present application by reference. Therefore, the Applicants request that the Examiner withdraw the objection to claims 16, 8 and 24.

Rejection under 35 U.S.C. §102(e) as being anticipated by *Zhang et al.*

The Examiner rejected claims 9-13 and 17-21 under 35 U.S.C. § 102(e) as being anticipated by *Zhang et al.* U.S. Patent Number 6,606,406 (hereinafter "Zhang").

The Examiner cites 35 U.S.C. § 102(e) and a proper rejection requires that a single reference teach (i.e., identically describe) each and every element of the

rejected claims as being anticipated by Zhang.¹

To begin, the Applicants have canceled claims 13 and 21 without prejudice, thereby rendering their rejection moot.

The Zhang reference teaches a method and system for progressive stereo matching of digital images. Although the Zhang reference mentions using a distributed computing environment, the Zhang reference does not mention any particular distribution of processing or any advantages or motivation for any particular distribution of processing functions. Zhang, Column 3, line 64 to Column 4, line 3.

With regards to independent claim 9, Applicants have amended independent claim 9 to more clearly specify the division of processing between a first processor and a second processor, as well as to more clearly define the "communicating the first set of distinct image features, the second set of distinct image features, and a plurality of correspondences of distinct image features to a second processor, wherein the plurality of correspondences comprises the first correspondence." A typographical transposition of "feature images" was also corrected to be "image features." Independent claim 17 has been similarly amended. Support for these amendments is found in the specification at, for example, page 8, lines 15-25; page 14, line 5 to 18; page 18, lines 1-27; and page 20, lines 12-14. No new matter has been added by these amendments.

The Applicants have further amended independent claims 9 and 17 to more clearly describe the "determining, on the second processor, a final correspondence of distinct image features detected in a second plurality of

¹ See MPEP §2131 (Emphasis Added) "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). "The identical invention must be shown in as complete detail as is contained in the ... claim."

images by processing the first set of distinct image features, the second set of distinct image features, and the plurality of correspondences." Support for these amendments is found in the specification at, for example, page 19, lines 1-27 and page 20, lines 12-14. No new matter has been added by this amendment.

The Applicants respectfully submit that the division of processing as specified by the amended claims provides the advantages described above by obviating the communication of large amounts of data between the first processor and the second processor. The Applicants respectfully assert that this advantage is not taught, suggested or implied in the cited prior art references.

The Applicants respectfully submit that the limitations of amended independent claims 9 and 17 are incompatible with the operation of the Zhang reference. The Zhang reference teaches that actual image pixels are iteratively processed in the search range module 320 and the correlation module 330. Zhang, Column 6, lines 30-60. In Zhang, the last module of the stereo matching module 240 is a classification module 340, which only classifies the output of the correlation module based upon statistics observed for that output. Zhang Column 6, lines 53-56 and column 14, line 57 to column 15, line 26. Since all modules that process "distinct image features" in the Zhang reference iteratively process the entirety of image pixels to refine the "distinct image feature" determination, it is impossible that a processing module would operate, as is set forth for the present invention, by "determining, on the second processor, a final correspondence of distinct image features detected in a second plurality of images by processing the first set of distinct image features, the second set of distinct image features, and the plurality of correspondences" as is set forth by amended independent claims 9 and 17. The Applicants respectfully assert that such an adaptation of the Zhang reference would lead to an inoperable system. If references taken in combination would produce a "seemingly inoperative device," such references have been held to teach away from the combination and thus cannot serve as predicates for a prima facie case of obviousness. *In re Spinnoble*, 405 F.2d 578, 587, 160 USPQ 237, 244 (CCPA 1969) (references

teach away from combination if combination produces seemingly inoperative device); *see also In re Gordon*, 733 F.2d 900, 902, 221 USPQ 1125, 1127 (Fed. Cir. 1984) (inoperable modification teaches away).

The Applicants have further amended dependent claim 12 and 20 to provide for correct antecedent basis in response to the above described amendments to claims 9 and 17, from which they depend. No new matter has been added by these amendments.

With regards to the rejection of claims 11 and 19, the Applicants respectfully point out that the Zhang reference does not discuss "wherein the steps of the method are performed repeatedly to process real-time video data." (emphasis added). Item 470 of FIG. 4 as referenced by the Examiner refers to the iterative processing of pixels in a single set of images in order to find new unambiguous pixel matches in the same set of images. Zhang, column 8, lines 18-57. The Applicants respectfully assert that the Examiner is confounding the iterative processing of the same set of images in Zhang with the repeated performance recited by claims 11 and 19 of the sequential set of different images contained in real-time video data. In fact, the Applicants respectfully assert that the Zhang reference never mentions processing video or any sequentially captured sets of images.

With regards to the rejection of claims 12 and 20, the Applicants respectfully assert that the teachings of Zhang do not teach "wherein the step of detecting and the step of determining a first correspondence are performed in the first processor that is associated with a camera which captured the first image." (Emphasis Added). The Examiner points to item 240:330 in FIG. 3, and the processing described at Column 6, lines 43-46 as a teaching of this limitation. Office Action, page 4, last paragraph through page 5, first paragraph. The Applicants respectfully assert that the Zhang reference teaches no association between any processing and a camera that captures a particular image. In fact, the referenced FIG. 3, shows "multiple images 350" as all feeding into the

"STEREO MATCHING MODULE 240" and the illustrated processing sub-modules therein. The "multiple images 350" are described as "multiple images (box 350) representing a scene." Zhang, Column 6, lines 43-44. Further, FIG. 2, as described at Column 6, lines 8-17, explicitly describes the multiple images, IMAGE (1) OF SCENE 210, IMAGE (2) OF SCENE 220, and IMAGE (3) OF SCENE 330 as all being provided to "a STEREO MATCHING MODULE 240 that receives the images". The Zhang reference does not discuss multiple processors, let alone a "processor that is associated with a camera which captured the first image" as is recited for claims 12 and 20.

Additionally, Applicants note that dependent claims 10-12, 14-16 and 25-26; and 18-20, and 22-24 depend, directly or indirectly, from amended independent claims 9 and 17, respectively. As discussed above, amended independent claims 9 and 17 distinguish over the cited prior art. Since dependent claims include all of the limitations of the independent claims from which they depend, Applicants further assert that dependent claims 10-12, 14-16 and 25-26; and 18-20 and 22-24 also distinguish over the cited prior art as well. Therefore, Applicants respectfully assert that the Examiner's rejection of claims 9-12, 14-16 and 17-20 and 22-24 under 35 U.S.C. §102(e) as being anticipated by Zhang should be withdrawn and that claims 9-12, 14-20 and 22-26 should be allowed.

Rejection under 35 U.S.C. §103(a) as Unpatentable over *Zhang et al.*

The Examiner rejected claims 1-5 under 35 U.S.C. § 103(a) as being unpatentable over *Zhang et al.*, U.S. Patent No. 6,606,406 (hereinafter "Zhang").

The Examiner recites 35 U.S.C. §103. The Statute expressly requires that obviousness or non-obviousness be determined for the claimed subject matter "as a whole," and the key to proper determination of the differences between the prior art and the present invention is giving full recognition to the invention "as a whole."

The Applicants have further amended independent claim 1 to more clearly define the following elements:

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a plurality of initial image correlators, wherein each initial image correlator within the plurality of initial image correlators is communicatively coupled with at least one of the image feature detectors within the plurality of image feature detectors, with each initial image correlator within the plurality of initial image correlators determining a respective first correspondence of distinct image features within at least two images of the first plurality of images, the plurality of initial image correlators thereby determining a plurality of correspondences;

a final image correlator, separate from the plurality of initial image correlators, for determining a final correspondence of distinct image features detected in a second plurality of images by processing the first set of distinct image features, the second set of distinct image features, and the plurality of correspondences; and

a communications interface communicatively coupling each of the plurality of initial image correlators to the final image correlator in order to communicate the first set of distinct image features, the second set of distinct image features, the first correspondence from each of the plurality of initial image correlators to the final image correlator.

Support for these amendments is found in the specification at, for example, page 8, lines 15-25; page 14, line 5 to 18; page 18, lines 1-27; and page 20, lines 12-14. No new matter has been added by these amendments.

In the rejection of claim 1, the Examiner correctly states that "Zhang, et al. does not expressly provide a plurality of feature detectors and initial correlators." Office Action, page 6, first paragraph. The Examiner, however, goes on to state "it would have been an obvious matter of design choice to modify the plurality of feature detectors and initial correlators by using a single feature detector, i.e., camera, and a single processor, i.e., stereo matcher or correlator as taught by Zhang, et al. (See Figs. 2 and 3) col. 1, lines 36-44) to determine an initial and final correspondences, since no new or unexpected results are seen to be attained by providing a plurality of feature detectors and initial correlators, and it appears that the single camera and single processor would equally generate an initial match and final match between multiple images."

The Applicants respectfully traverse several of the Examiners assertions. The

Applicants respectfully point out that the stereo matching module 240 operates iteratively on the same image data. Zhang, column 6, lines 17-60. The Examiner correctly describes this as “progressive stereo matching” that “obtains a plurality of correlations until it reaches a suitable, i.e., final, match.” Office Action, page 6, first paragraph. Zhang describes this iterative, or progressive, matching as:

The present invention solves the problems discussed above of prior matching techniques by starting with a few reliable initial point matches and progressively adding new pixel matches during an iterative matching process. At each iteration only reliable and unambiguous matches are selected and added to a set of reliable pixel matches. In addition, the robustness of the present invention is increased by using a correlation match measure that allows rotation of the match template used to search for pixel matches.

Zhang, column 6, lines 19-28. The Applicants respectfully assert that the iterative processing of the same set of images, as taught by Zhang, is completely unrelated to performing the parallel processing of multiple, and different, sets of images as is claimed for the present invention.

Applicants respectfully traverse the assertion that “no new or unexpected results are seen to be attained by providing a plurality of feature detectors and initial correlators.” Office action, page 6, first paragraph. As discussed above, the division of processing as set forth in the claims of the present invention provides an advantageous distribution of processing so as to reduce the data communication requirements between these multiple processors. As discussed above, the Applicants respectfully assert that the only basis for an assertion of obviousness for this aspect of the claimed invention is from the Applicants own disclosure. As further discussed above, the Applicants respectfully assert that such hindsight reconstruction is improper.

If, however, the Examiner is taking official notice of the lack of new or unexpected results, the Applicants respectfully traverse this taking of official notice. Official notice is proper for “facts outside of the record which are capable

of instant and unquestionable demonstration as being 'well-known' in the art."²
Applicants respectfully request that a reference be cited.³

If, however, the Examiner's statements are based on facts within the personal knowledge of the Examiner, the Applicants respectfully request that the Examiner support these references by filing an affidavit as is allowed under MPEP §707, citing 37 CFR 1.104(d)(2), and as specified in MPEP §2144.03.⁴

Further, the invention set forth by amended independent claim 1, as is similarly described above for independent claims 9 and 17, advantageously divides the recited processing among various processing elements in order to reduce data communications between processors. As described in the specification, this architecture further provides for easy scalability of processing elements, particularly in light of the reduced data communications and reduction of data provided to the final image processor. Specification, pages 8-10. The recited division of processing and the advantages set forth above are not taught or suggested by the cited prior art references. The Applicants respectfully assert that an assertion of obviousness for a system with the particular separate processing elements recited by amended independent claim 1 can only be based upon hindsight reconstruction in light of the Applicants' own disclosure. It is well-settled that the references themselves must provide some motivation or reason for one of ordinary skill in the art (working without the benefit of hindsight reconstruction using the Applicant's specification) to make the necessary changes in the disclosed systems. The mere fact that a reference may be modified in the direction of the claimed invention does not make the modification obvious unless the reference expressly or impliedly teaches or suggests the desirability of the modification. *In re Gordon*, 221 USPQ 1125, 1127 (Fed. Cir.

² See, MPEP §2144.03, citations omitted.

³ See, MPEP §2144.03, "If the applicant traverses such an assertion the examiner should cite a reference in support of his or her position."

⁴ See, MPEP §2144.03, "When a rejection is based on facts within the personal knowledge of the examiner, the data should be stated as specifically as possible, and the facts must be supported, when called for by the applicant, by

1984); *Ex parte Clapp*, 227 USPQ 972, 973 (Bd. App. 1985); *Ex parte Chicago Rawhide Mfg. Co.*, 223 USPQ 351, 353 (Bd. App. 1984).

The Applicants have also amended dependent claim 5 to more clearly describe:

An image processing system according to claim 4, wherein each initial image correlator within the plurality of initial image correlators and the final image correlator are separate from one another, and wherein the communications interface provides a communications channel for each correspondence determined by each initial image correlator.

Support for this amendment is found in the specification at, for example, page 11, lines 15-20; page 12, line 15 through page 13, line 2; and page 18, lines 1-14. No new matter has been added by this amendment.

As discussed above with regards to amended independent claims 9 and 17, the cited prior art references clearly do not teach or suggest the processing architecture defined by amended dependent claim 5, which also includes the limitations set forth in dependent claim 4 from which it depends. The Applicants respectfully assert that the separation of processing as set forth in amended dependent claim 5, wherein “wherein each initial image correlator within the plurality of initial image correlators and the final image correlator are separate from one another” are not taught or suggested by the cited prior art.

With regards to the rejection of dependent claim 4, the Applicants refer to the remarks made above with respect to dependent claims 12 and 20 and incorporate them by reference. The Examiner refers to FIG. 8 of the Zhang reference. The Applicants respectfully point out that the two image pairs of that figure, referred to by reference numerals 820 and 830, both contain the same images, i.e., image 800 and image 810. The description of this figure further supports that these are the same images, only that element 830 has matched points. Zhang, column 11, lines 25-35.

an affidavit from the examiner.”
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The Applicants further note that dependent claims 2-5 depend from amended independent claim 1. As discussed above, amended independent claim 1 distinguishes over the cited prior art. Since dependent claims include all of the limitations of the independent claims from which they depend, Applicants further assert that dependent claims 2-5 also distinguish over the cited prior art as well. Therefore, Applicants respectfully assert that the Examiner's rejection of claims 1-5 under 35 U.S.C. §103(a) over Zhang should be withdrawn and claims 1-8 should be allowed.

CONCLUSION

The foregoing is submitted as full and complete response to the Official Action mailed November 30, 2004, and it is submitted that Claims 1-12, 14-20 and 22-26, are in condition for allowance. Reconsideration of the rejection is requested. Allowance of Claims 1-12, 14-20 and 22-26 is earnestly solicited.

The present application, after entry of this amendment, comprises twenty-four (24) claims, including four (4) independent claims. Applicants have previously paid for twenty (24) claims, including four (4) independent claims. Applicants, therefore, believe that an additional fee for the claim amendments is currently not due.

If for any reason the Examiner finds the application other than in condition for allowance, or the Examiner believes that there are any informalities which can be corrected by Examiner's amendment, a telephone call to the undersigned at (561) 989-9811 is respectfully solicited.

No amendment made was related to the statutory requirements of patentability unless expressly stated herein. No amendment made was for the purpose of narrowing the scope of any claim, unless Applicants have argued herein that such amendment was made to distinguish over a particular reference or combination of references.

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The Commissioner is hereby authorized to charge any fees that may be required or credit any overpayment to Deposit Account **50-1556**.

In view of the preceding discussion, it is submitted that the claims are in condition for allowance. Reconsideration, re-examination, and allowance of the claims is requested.


Respectfully submitted,

Date: March 30, 2005

By:


Jose Gutman
Registration No. 35,171

By:


Jeffrey N. Giunta
Registration No. 42,583

Customer Number 23334
Fleit, Kain, Gibbons, Gutman,
Bongini & Bianco P.L.
One Boca Commerce Center, Suite 111
551 N.W. 77th Street
Boca Raton, FL 33487
Telephone No.: (561) 989-9811
Facsimile No.: (561) 989-9812

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